Chapter 8 Impacts of future technology

8.1 Technology impacts on the RFDS

Advances in technology and research have played an important role in improving gas recovery from unconventional plays of the Rocky Mountain region. Several key areas likely to impact Raton Basin development are directional/horizontal drilling, well stimulation, and the remediation of produced water. Each of these may eventually have an impact on development of the eastern Valle Vidal Unit. The technologies listed below, if successfully applied to the Raton Basin, could increase the economic viability of production of individual wells and/or increase the effectiveness of draining reservoirs as a whole. However, given the current level of deployment, these technologies are *not considered to be alternative scenarios* to that recommended in the conclusions of this RFDS, *but rather potentially desirable future possibilities*.

8.2 Directional and horizontal drilling

The objectives of directional (purposely deviated) and horizontal drilling are typically related either to avoiding surface occupation or to increasing production efficiency. These two objectives are not always compatible. Avoidance of surface occupancy is typically due to topographic or environmental concerns. In this case, a drilling location will be selected as near as possible to the subsurface target and a well bore will be constructed in such a manner as to minimize cost while achieving the subsurface target. The goal is to capture the same reserves that would have been achieved from a vertical well, had one been drilled. In terms of economic efficiency, such wells are less efficient due to increased cost (approximately 20%) and higher operating expenses with no change in producible reserves. Such wells can present difficulties in operation, particularly when artificial lift is required because inexpensive rod pumps (driven by pumpjacks) cannot operate when the borehole has “doglegs” or bends.

Application of horizontal well technology in the onshore United States has been increasing in recent years. For example, horizontal well activity in the San Juan Basin has increased lately in the Fruitland Coal, as industry realizes the benefits of such practices. However, not all reservoirs are candidates for this type of completion. A first step in selecting appropriate reservoirs is to screen the key parameters for commercial success. For example, natural fracture orientation and intensity, net pay and vertical permeability, susceptibility to formation damage, reservoir pressure, anisotropy, and drilling/completion costs need to be understood in the context of penetrating the reservoir with a horizontal well.

Fractured reservoirs such as coals may be more suitable for horizontal drilling because of the ability to intersect fractures (cleats). However, where artificial lift is required, this drilling technology often proves impractical. We believe that the thin and discontinuous coalbeds in the eastern Valle Vidal Unit, and the relatively low net coal existing over a large gross vertical interval, are conditions that are not conducive to horizontal drilling. The shallow depth of the CBM reservoir would make horizontal well construction excessively expensive compared to vertical wells. We do not recommend horizontal drilling as a viable method during the 20-year life of the RFDS.

8.3 Completion technology

Hydraulic fracture techniques have evolved over the years with improvements in fluids, proppants, and design. Hydraulic fracturing is achieved by pumping large volumes of fluid (typically fresh water or a fresh water-nitrogen-soap foam), under pressure, with viscosifying additives (guar gum is typical) and quartz sand. The purpose is to cause the formation of interest to fracture under pressure, with the sand propping open the fractures to allow reservoir fluids to flow through the newly opened conduits. Advances in hydraulic fracturing of low permeability formations will have, perhaps, the greatest potential impact on future development; particularly, to improve the effectiveness in thin, multiple pay zones. Currently identified issues that require further improvement are:

- Cost reduction of all stimulations is a priority among all operators. The goal is to increase fracture efficiency while reducing cost per application in future well completions.
- Research is required to achieve more effective hydraulic fracturing of naturally under-pressured or semi-depleted formations.
- There is currently a need to improve multi-zone or multi-formation stimulations within a single well bore.
- All stimulations tend to cause some degree of formation damage (pore network plugging) such that the efficiency of the stimulation is less than ideal; therefore there is a need for better identification of sensitivity of formations to fluid interaction-related damage and need for research into optimal, non-damaging fluid systems
- There is a regional shortage of availability of better-engineered liquefied CO_2 delivery systems. This limits the application of, and increases the cost of, less damaging liquid CO_2 fracturing.

Hydraulic fracturing techniques were applied to all wells that are currently producing gas at the Vermejo Park Ranch. This stimulation technique appears to be a critical element in economic production of the CBM reservoir. There, economic improvements in a 20-year time frame would likely result from improved stimulation methods.

8.4 Produced water treatment and filtration

Production of formation water is a necessary requirement for production of coalbed methane. Much of the gas content of coals is in the form of molecules of methane physically adsorbed on organic particles in the coal matrix. By producing formation water from the coal porosity system, formation pressure is reduced. Reduction of formation pressure is the primary mechanism for the desorption of methane from the coal matrix. Water produced as a byproduct of pressure reduction cannot be disposed of by returning it back into the formation from which it was produced because this would replenish the pressure and halt the production process. Therefore, produced waters must be disposed of in an approved fashion. Generally, this can be done by surface discharge if the water quality is suitable, or disposal by injection into a deep disposal zones if the water quality is poor, however, requirements differ according to State regulation. In the Colorado part of the Raton Basin, produced waters of sufficient quality are pumped to a surface pit for settling of coal fines, then transferred to surface drainages, adding volume to larger rivers. In New Mexico, Raton Basin produced water is required to be injected into state-approved deep disposal zones.

An argument can be made that discharge to the surface allows water of acceptable quality to be reused by adding to local stream flow. There may be beneficial uses of the water downstream in agriculture, manufacturing, and municipal applications. However, if fresh water is pumped into a saline aquifer for disposal, it is essentially permanently removed from reuse and thus wasted.

Water produced at the Vermejo Park Ranch is best classified as brackish, in the range of 2,000 to 10,000 mg/l total dissolved solids. Current methods to improve the quality of brackish water for beneficial use tend to be excessively expensive compared to the option of deep saline aquifer injection. There are many ongoing collaborative research efforts underway in New Mexico and elsewhere to produce useable, even drinkable water from brackish aquifers. One pilot project seeks to aid the City of Alamogordo and Holloman Air Force Base by adding significantly to the drinking water supply through application of innovative filtration technology (Allan Sattler, Sandia National Laboratories, 2003, pers. comm.). Another effort being conducted by Sandia National Laboratories, New Mexico Institute of Mining and Technology, and others is focusing on chemical treatment of coalbed methane produced waters in the San Juan and Raton Basins. An initial conclusion of the water quality evaluation stage of that project is that some Raton Basin produced waters already meet EPA surface discharge requirements. Those that do not meet discharge requirements would qualify with minimal treatment.

As stated above, it is not the purpose of this RFDS to determine specific environmental impact of oil and gas operations. There are, however, obvious development alternatives that further analysis should consider relative to optional oil and gas operation methods. Given a supportive regulatory environment and growing commercial availability of treatment and filtration technology already available, produced water could be effectively and economically improved at either the wellhead or at centralized facilities to meet reasonable requirements for a surface discharge option in the eastern Valle Vidal Unit should that option be found desirable. A surface discharge option for produced water would not significantly reduce the footprint of coalbed methane operation if a lease-centralized treatment facility would be required, such a facility being similar in size to a subsurface disposal facility. It is important to note that as the coalbed aquifer is depleted over time, the volumes of water being produced will likely decrease.